Red-Flag Review by Dr. Kendra Zamzow and Dr. David Chambers, Center for Science in Public Participation

The following review of the Aquila Back Forty Wetland Permit application was conducted by Dr. Kendra Zamzow of the Center for Science in Public Participation (CSP2), which analyzes mining applications and provides objective research and technical advice to communities impacted by mining. Additional review of the Feasible and Prudent (Least Environmentally Damaging Practicable) Alternatives Analysis is provided by Dr. David M. Chambers, president of CSP2. Their review is presented in two parts, attached.

CSP2 Red-Flag Review Part 1: *§6. Feasible and Prudent (Least Environmentally Damaging Practicable) Alternatives Analysis (LEDPA)*

CSP2 Red-Flag Review Part 2: *Wetlands Permit – Additional Findings (Hydrology & Indirect Impacts)*

Dr. Kendra Zamzow is an environmental geochemist based in Alaska. She has a Ph.D. in Environmental Chemistry from the University of Nevada, Reno and a B.A. in Molecular and Cellular Biology from Humboldt State University, California. At UNR she operated a sulfate-reducing field bioreactor treating mine water discharge at an abandoned copper mine Superfund site, and provided laboratory water chemistry analysis for sulfate, metals, and alkalinity.

Dr. David Chambers has 40 years of experience in mineral exploration and development – including 15 years of technical and management experience in the mineral exploration industry, and 25 years as an advisor on the environmental effects of mining projects both nationally and internationally. He is a registered professional geophysicist (California # GP 972) with a Masters Degree in Geophysics from the University of California at Berkeley, and Professional Engineering Degree in Physics from the Colorado School of Mines. He has provided assistance to public interest groups and tribal governments on proposed, operating, and abandoned mines located throughout the United States and Canada — reviewing environmental impact studies, analyzing the potential adverse effects on surface and groundwater quality of acid mine drainage and metals leaching from mine point discharges and seepage from mine waste storage facilities, and proposing alternative methodologies to avoid these impacts.

Submitted jointly on behalf of the Front 40 Environmental Group and the Mining Action Group of the Upper Peninsula Environmental Coalition. Independent review of the Aquila Back Forty Wetland permit is made possible by the generous support of groups and individuals concerned about the future health of the Menominee River, including Freshwater Future, Superior Watershed Partnership, the Western Mining Action Network, DuPage Rivers Fly Tyers (DRiFT), Northern Illinois Fly Tyers (NIFT), Badger Fly Fishers, M&M Great Lakes Sport Fisherman, Wisconsin Smallmouth Alliance, Fly Fishers International, Great Lakes Council of Fly Fishers International, the Emerick Family Fund, and individual fishing enthusiasts throughout the Great Lakes area.

CENTER for SCIENCE in PUBLIC PARTICIPATION
PO Box 1250 Chickaloon, AK 99674
Phone (907) 354-3886 / web: www.csp2.org / e-mail: kzamzow@csp2.org
"Technical Support for Grassroots Public Interest Groups"

January 15, 2018

Kathleen Heideman, gadmin@savethewildup.org

Re: Aquila Back Forty wetland permit November 2017

Dear Kathleen:

The Center for Science in Public Participation provides technical advice to public interest groups, nongovernmental organizations, regulatory agencies, mining companies, and indigenous communities on the environmental impacts of mining. CSP2 specializes in hard rock mining, especially with those issues related to water quality impacts and reclamation bonding.

This letter represents a brief review of issues on the wetland permit application as revised in November 2017. Materials reviewed include all or parts of the following:

1. Aquila Resources Inc. 2017. Potential Indirect Wetland Hydrology Impacts, Back Forty Project, ID 17A021, 401p. November.

2. Aquila Resources Inc. 2017. Permit Application – Back Forty project, ID 17A021. MDEQ/USACE Joint permit application for: wetland protection, inland lakes and streams, floodplain.
   a. Volume I, Section 3 – Wetland Impact Summary, October 2017.
   b. Volume II, Section 5 – Wetland Delineation and Stream Evaluation, May 2017
   c. Volume II, Section 6 – Feasible and Prudent (least environmentally damaging practicable) Alternatives Analysis, October 2017
   d. Volume II, Section 7 – Summary of Environmental Studies, September 2017, 1p
   e. Volume VI, Appendix A1 – Potential Indirect Wetland Hydrology Impacts, November 2017
   f. Volume VII, Appendix D within Appendix A2 – Response to MDEQ Request for Clarification dated October 20 2017

3. Preliminary Economic Assessment, Technical Report on the Back Forty Deposit, Menominee County, Michigan, USA, Aquila Resources Inc, Effective Date: April 26, 2012

Introduction

The Aquila project proposes to mine a massive sulfide deposit primarily for copper, zinc, and gold over seven years using an open pit. Ore would be processed on site. The ARD risk is very high. Most material contains sulfides, and there is very little natural carbonate for buffering. Within the 1,095 acres property are 93 acres of wetlands and over 900 linear feet of streams; of this, 706 acres is needed for waste material, including 42 acres to hold five ore stockpiles (Vol II, Section 6).

The mining permit and wetland permit are inextricably linked. The location and size of proposed mine site facilities as presented in the November 2017 Wetland Permit Application are different from those presented in the Mining Permit Application, and pose risks to wetlands that have not been analyzed.

<u>Wetland Permit Key findings</u>

- An environmental analysis needs to be conducted comparing the new proposed facility siting impacts on wetlands with the siting approved in the mining permit. The proposed single mine waste storage area is now two areas, and is much larger. The description of what is to be contained in each is inadequate and there is no description of the protections to be put in place.

- An economic analysis needs to be conducted to determine the feasibility of moving the mill out of wetland areas.

- It appears that most of the stream and wetland impacts might be avoided if the mine facilities could be moved further upland to a dryland site, possibly on other state lands.

<u>Key Finding #1 Environmental analysis</u>

The wetland permit proposes siting mine facilities differently from the siting approved in the mining permit. The combined waste rock and tailings facility is much larger, due to a realization that waste material would be less dense than original calculations applied to the design. This is important not only to the potentially greater environmental impact due to the larger area filled, it is also important to determine specifics of material that will be inside the storage areas and the material used to contain the waste.

Co-disposal waste facility. Co-disposal of waste rock and tails in a single, lined facility is proposed *"To minimize the areal footprint of the tailings and ….save acreage"* (Vol II, Section 6, Part 5.5). There is very little description of the waste management facilities, which have been significantly changed in size and location relative to the mining permit. The document also notes *"upon closure of the mine, much of the waste rock temporarily stored aboveground will be relocated to the pit for subaqueous disposal… "* but does not specify where waste rock would be stored or what protections would be in place around it. Seepage from temporary storage stockpiles is typically contaminated, and needs to be collected to avoid potential contamination to surface and ground waters, including those connected to wetlands.

An alternative for a separate waste rock facility (Alternative F) was discarded.

There are several lines of questioning that warrant further environmental analysis.

The former site plan (now Alternative D) segregated oxide and flotation material to "optimize leachate management". How has leachate management now changed, and specifically what is the difference with respect to impact to wetlands due to moving, managing, and treating leachate?

The former site plan was discarded in part because waste would be "less dense" than anticipated. There is no explanation for what is behind the anticipated change in waste material density that drove the need for the greater area required for waste disposal, or why a change in anticipated density drove the separation of oxide and flotation storage facilities, or how this changes the impacts to wetlands. The brief analysis of Alternatives F, G, and H suggest that the driving reason for a single facility was to reduce the cost of installing a liner, and was not predicated on reducing the impact to wetlands.

Previously the tails were to be dewatered to 73-81% solids (Mining Permit Application Appendix H Section 4.7). There is no description of whether the tailings management or water content has changed, and whether that is part of the reason that waste will be "less dense" than previously calculated. There is an alternative (Alternative H) for thickened tails co-disposal with waste rock, rejected because of the need for an "intricate system" of access roads. A more complete description, weighing economic and environmental impacts is needed to determine whether the thickened tails option is feasible and prudent. Additional water content from tails may pose an additional risk regarding embankment integrity, which in turn is a risk to wetlands.

There is no description of whether the facility will be built as described in the mining permit –lined with leak detection. Nor is there an economic analysis as to how the increased cost – for increased area of liner, pad, and leak detection – will impact potential profits. This is important, as the primary reason for rejecting off-site milling was that the material was too low grade to warrant the cost of transport. This suggests a very low profit margin. A detailed description of the design of the new waste facility, including whether protections such as the thickness of the liner have changed, is warranted, along with analysis of whether changes pose any change in the risk to wetlands (e.g. higher volume of leakage due to greater lined area) or necessary mitigation, and how the increased cost compares to moving milling off-site.

The collection sumps are now in new locations, including one in the North and one in the Northeast corner of the facility that are very close to wetlands (WL-C1, WL-40/41). This may pose a risk to wetlands that has not been evaluated, such as the potential for uncaptured leachate to settle in wetlands or the potential for sumps to lower the water table.

In the mining permit, non-acid generating (NAG) waste rock was to be used to build the waste storage area embankments containing the thickened tailings mixed with waste rock (EIA Vol I, Section 5.6). Greater volume of this material will now be required. Approximately 75% of the waste rock was determined to be potentially acid generating (PAG). An analysis needs to be conducted to determine whether there is enough NAG material to construct sound embankments.

The embankment material needs to be both NAG and not subject to leach contaminants. Previous testing determined that several contaminants will leach from tailings or waste rock. Copper, cadmium, selenium, and zinc do not require acidic conditions to leach and are highly toxic to aquatic life. Arsenic and copper can leach under neutral pH if conditions are anoxic, as could be expected in pore spaces of an embankment.

Scenarios under which PAG material or NAG material that leaches contaminants is necessary to construct the embankment would put wetlands at a long term risk, potentially enough risk to warrant a new analysis of off-site milling.

Pit location mine waste storage area. A new mine waste storage area is shown on figures on the southern perimeter of the pit. Is this where "waste rock will be temporarily stored above ground"? Or is it to continue to be a location for "overburden and soils stockpile" as described in previous versions of the wetland permit? There does not appear to be an area for soil stockpiles in the new design.

It is confusing that Alternative F (separate waste rock facility) was discarded but this new waste area for unspecified waste was incorporated into the wetland permit mine site design. The separate waste rock facility was eliminated in part because of the additional cost of a liner. How will this new storage area be designed? Will it be lined (thickness?) with leak detection? How is this area different, economically and environmentally, from Alternative F?

Whether this site will contain waste rock or overburden changes the risk to wetlands and the River. This site would be built directly on top of a "valley bottom" wetland that is in contact with groundwater.If the area is to store waste rock for backfill to the pit, it is likely that the waste rock is high in sulfide (PAG), which is the material that should be backfilled and flooded to reduce oxidation and acid generation. There is no description of whether PAG material will be separated from other waste rock, or where it will be stored. Waste rock piles that are uncovered allow significant oxygen to move through them; if PAG waste rock is placed in a storage pile, it will go acid.

Given the terrain, direction of water flow, and proximity of valley wetlands and the River, this poses risks to wetlands – and aquatic resources in the River – that have not been analyzed. There is no description of the design of the storage area, which should describe the pad, liner, liner thickness, rate of leakage through the liner, leak detection, sump design, how water is pumped away from the waste rock area, and any measures taken to prevent leachate or dust from contaminating the nearby wetlands and River. There is no discussion of whether additional monitoring wells should be placed around the waste storage area.

As part of the analysis, a hydrologic model of a high-runoff situation during high soil saturation should be conducted to determine risk of, and design mitigation for, potential flood situation. Similarly mitigation should consider the risks posed by high precipitation events that cause high runoff from and seepage through the waste rock pile. From the other direction, environmental analysis should include climate predictions regarding the River floodplain, and consider whether there is reasonable risk of floodwater reaching the waste rock storage area. In other geographic locations, the 100-year flood plain delineation (1:100 chance of flood every year) is moving, as those areas experience this level of flooding more frequently.

Placing waste rock next to the pit appears to be an economical solution to the cost of moving waste rock, but from an environmental perspective it is a much riskier location than the design approved in the mining permit. The best decision would be to move this material back away from the River, but if it is left in place, the cut off wall, currently proposed along the west side of the pit, could be extended as an additional barrier to the migration of any leakage from the facility.

There is also good reason to plan for long term storage of the backfill waste rock. Aquila has provided details, including measured reserves and adit designs, for an underground mine that would start from the bottom of the pit. The pit could not be backfilled until the entire works – open pit and underground mining – were complete. Placing waste rock, particularly PAG waste rock, on top of a wetland and adjacent to the River, knowing that it may be there for many years past the life of the open pit, increases the risk to wetlands and aquatic resources in the River. Although there is no formal proposal for underground mining, it is reasonable and foreseeable. Therefore the full potential life of the mine should be considered when evaluating feasible and prudent alternatives that are the least damaging to wetlands.

Closure footprint. The footprint of the single, co-disposal Tailings and Waste Rock Management Facility (TWRMF) at closure (R-Potential Indirect Impacts, Figure 5-2) is much smaller than the facility during operations (Figure 5-1). The size is reduced at closure as waste rock is moved to backfill the pit. *The only Project feature that will remain (following closure) is the capped and reclaimed tailings and waste rock stockpile. This facility is much smaller than that which will exist during operations,* ***because much of the waste rock will be relocated to the pit*** *following operations*

However, there is now a new storage area next to the pit, which could potentially be utilized to store backfill waste rock. If the closure footprint is larger than expected, there will be greater impact to wetlands. There is also the issue, as mentioned above, that if underground mining commences and begins from the pit floor, waste rock backfill will be considerably delayed.

Wetland hydrology. Much of the data on which the groundwater model, and therefore the condition of wetlands during operations, is based on was not collected on site. Precipitation, evapotranspiration, runoff (from uplands), runon (to wetlands), vertical hydraulic conductivity, and stream flow were not measured on site. Although models went through sensitivity analysis, it is difficult to have confidence when models are not verified with on-site data. As just one example, the model "releases" snowmelt evenly over 30 days in April, but without stream flow this cannot be verified as a valid mechanism in the model. The model needs to be validated, and tested towards both extremes – with wetland receiving very little water (impacts due to drying) and receiving high amounts of water (impacts to vegetation from extended saturation or flooding).

Eleven piezometers (as shallow/deep pairs) were installed in 2017, nearly doubling the number of piezometers. It is primarily through these that the water table is tracked. It would seem prudent to collect at least one season with these additional instruments prior to providing a wetland permit, as they will help to verify whether some wetlands are perched and unaffected by groundwater drawdown.

As a separate issue, wetlands are expected to receive less water due to contact water management. With facility siting changed, will there be changes to which wetlands are impacted by contact water diversions?

Dewatering the pit. The pit is to be dewatered by sumps on the pit floor rather than through dewatering wells. Logistically this seems like it could be difficult. The applicant should provide examples of where this has been done at other mines. If, after permitting, it is determined that dewatering wells are needed, there will be impacts to wetlands, as it will cause a drop in the water table ("cone of depression" is well-documented at most mine sites).

Key Finding #2 Economic analysis of Alternative B

An obvious benefit to wetlands would be to move the ore processing off-site (Alternative B), resulting in a much smaller footprint. The alternative for processing ore off-site was rejected with no real analysis in either the 2015 Environmental Impact Assessment or the 2017 Wetlands Permit application.

A detailed economic analysis needs to be conducted to determine whether an off-site location could be feasible and prudent. The alternatives analysis stated that going off-site would increase environmental risk due to spills, increase greenhouse gas emissions, and that although there are former processing facilities that ore could be taken to, upgrading the mills would have technical challenges and be uneconomical based on the low grade ore. However, details are lacking. A detailed analysis could include some or all of the following:

- State the value of the ore as gold equivalent (AuEq – 48% of the project revenue is due to gold projection, PEA, 2012) in order to compare transportation cost and profit against similar mines. Ore value is currently presented as the grade of each individual metal in specific zones, which makes it impossible to compare to the AuEq grade of nearby mines.
- Provide economic analysis, complete with maps of land ownership, of nearby upland locations where milling could occur without impact to wetlands.
- Provide detailed economic analysis that shows the distance to the closest former mines or towns where ore processing could occur, along with the cost for truck and/or rail transport.

- Are there opportunities to utilize former mine facilities that would reduce or eliminate the cost of needing to install a liner? What other costs could be offset?

All of the project objectives (Vol II, Section 6) can potentially be met with an off-site facility, and some objectives could be enhanced (e.g. local jobs).

Key Finding #3 Alternative Location for Processing Facilities

The development of the mine and millsite property will require the destruction of 28 acres of wetlands and over 900 linear feet of streams (Vol II, Section 6). Approximately ½ mile to the east of the proposed minesite is a large block of state forest land. The referenced wetland information does not contain data on this parcel of land, but it appears to be largely upland forest.

An alternative that was not considered during previous analyses is moving the mine facilities to this upland site to minimize impacts to wetlands. This location is close enough to the proposed minesite that the increased transportation costs should not significantly impact the economics of the project. The Preliminary Economic Assessment for the mine shows that change in cash flow is least sensitive to the capital and operating costs, and most sensitive to the metal price and grade (PEA 2012, Figure 1-1).

Since the Michigan Department of Environmental Quality has the responsibility for protecting wetlands, it would be appropriate for MDEQ to evaluate this alternative prior to authorizing the destruction of wetlands where it may not be needed.

Additional issues

Non-contact water basins. Discharge would be through an outlet along riprap to minimize sediment release. Consideration should be given to allowing sediment to settle in settling basins, and releasing water through a manifold to reduce impacts.

Invasive species. The following could be more, rather than less, likely to increase the establishment of invasive species, and could be interpreted as an additional income source rather than an environmental protection: *Performing work in upland areas, such as mowing, grading, excavation, timber harvesting, and conducting invasive species monitoring in uplands.* (Vol II, Section 6, Part 5.7).

Thank you for the opportunity to comment on the wetland permit. Please feel free to contact us with questions or for further information.

Regards,

Kendra Zamzow

Kendra Zamzow, Ph.D.

David M Chambers

David M Chambers, Ph.D., P. Geop

CENTER for SCIENCE in PUBLIC PARTICIPATION
PO Box 1250 Chickaloon, AK 99674
Phone (907) 354-3886 / web: www.csp2.org / e-mail: kzamzow@csp2.org
"Technical Support for Grassroots Public Interest Groups"

January 21, 2018

Kathleen Heideman, gadmin@savethewildup.org

Cc: Dave Chambers, dchambers@csp2.org

Re: Aquila Back Forty wetland permit November 2017

Dear Kathleen:

The Center for Science in Public Participation provides technical advice to public interest groups, nongovernmental organizations, regulatory agencies, mining companies, and indigenous communities on the environmental impacts of mining. CSP2 specializes in hard rock mining, especially with those issues related to water quality impacts and reclamation bonding.

This letter represents a brief review of issues on the Wetland Permit Application as revised in November 2017, as a companion to the comments submitted on January 15, 2018. Materials reviewed in this memo include all or parts of the following. Volumes cited in this letter refer to the volume of the Wetland Permit Application.

Aquila Resources Inc. 2017. Permit Application – Back Forty project, ID 17A021. MDEQ/USACE Joint permit application for: wetland protection, inland lakes and streams, floodplain. November 2017.

- Volume I, Section 3 – Wetland Impact Summary, October 2017
- Volume II, Section 6 – LEDPA, October 2017
- Volume VII, Appendix A – Wetland piezometer logs, October 2017
- Volume VII, Appendix C – MiRAM forms, data collected July 2010
- Volume VII, Appendix D – Response to MDEQ, October 2017
- Volume VIII, Appendix B1 – Aquatic impact analysis, September 2017
- Volume VIII, Appendix B2 – Baseline water quality summary, September 2017
- Volume VIII, Appendix B3 – Reclamation plan summary, August 2017
- Volume VIII, Appendix B4 – Cut-off wall memo, August 2017
- Volume VIII, Appendix B6 – Proposed mussel relocation plan, September 2017
- Volume VIII, Appendix B7 – 100 year flood plain delineation, August 2017
- Volume VIII, Appendix B9 – Stream macroinvertebrate, water quality survey, Aug 2017
- Volume R – Potential Indirect Impacts to Wetlands, November 2017

Aquila Resources, Inc. 2017. Memo to MDEQ requesting extension for toxicity data. Dec 11.

NPDES permit #MI0059945, April 2017

- NPDES permit
- NPDES permit fact sheet
- MDEQ response to comment summary document
- MDEQ response to USFWS comments, April 5 2017

CSP2. 2017. Memo on AMD risk at the Back Forty mine *for* Menominee Tribe. June 17.

Introduction

The Aquila project proposes to mine a massive sulfide deposit primarily for copper, zinc, and gold over seven years using an open pit. Within the 1,095 acres property are 93 acres of wetlands and over 900 linear feet of streams; of this, 706 acres is needed for waste material, including 42 acres to hold five ore stockpiles (Vol II, Section 6).

The mining permit, NPDES permit, and wetland permit are inextricably linked. The location and size of proposed mine site facilities as presented in the November 2017 Wetland Permit Application are different from those presented in the Mining Permit Application, and pose risks to wetlands that have not been analyzed, and the NPDES permit specifies the quality of water allowed to the River, contacting aquatic organisms.

Wetland Permit Key Findings

- Function and value of proposed compensatory wetlands have not been adequately compared with impacted wetlands.
- Indirect impact analysis omits impacts from dust
- Inconsistencies and inadequate data regarding wetland hydrology information
    - Nearly all water balance data was collected with very minimal on-site data.
    - Snowmelt inputs to model were not collected on site.
    - Seepage is expected to flow from the River to the pit, necessitating a cut-off wall, but not expected to flow from adjacent wetlands to the pit.
    - Wetland hydrology inconsistent with assumptions on post-closure dilution of pit contaminants.
- Off-site milling would significantly reduce impacts to wetlands. This alternative was removed through the argument that doing so would eliminate the already thin profit margin and make the project uneconomical. However, other major costs have not been analyzed. Without this analysis, the economic viability of the mine as well as the ability to adequately treat wastewater and protect wetlands and aquatic resources is incomplete. These include:
    - No wastewater treatment plant design.
    - No comparison of the costs of a well-designed treatment plant versus mussel relocation and other impacts to aquatic resources.
- Assumption that mussel relocation will need to be done once.
- No analysis of the potential for mine activities to alter the potential of mercury to methylate, increasing (or decreasing) risks to aquatic life.

Key Finding #1 Wetland function and value

The most fundamental character of wetlands is not described. Wetlands are defined as "upland" (fed by precipitation) or "valley-bottom" (connected to groundwater). Water chemistry was "inconclusive" with regards to the water sources (Vol VIII App B2). Wetlands should be described based on vegetation, soil types, and hydrogeomorphology. Hydrogeomorphic classes of wetlands could include: depressional, riverine, sloped, and so forth. This information is found in the MiRAM forms (Vol VII App C) but the terminology is not used in the rest of the application. Wetlands should be defined using common terminology as accepted by the National Wetlands Inventory and wetland specialists.

In order for appropriate compensation, the function of wetlands must be described (groundwater discharge and recharge, stormwater retention, water filtration, carbon storage, wildlife/bird habitat and forage, etc.) (Vol R, Section 7). Some features (habitat, invasive species, etc.) are included in the MiRAM evaluation, some are missing (carbon storage, stormwater retention, water filtration) and none of the values are described outside the MiRAM forms.

- **The description of function and value of impacted wetlands is insufficient.** Vol I Section 3 should have a much more complete description of the function and value of impacted wetlands.

- **The function and values of the proposed wetlands for compensation have not been described sufficiently or compared to impacted wetlands.** A section of the Wetland Permit Application should compare the function and value of proposed compensatory wetlands to impacted wetlands, taking this information out of MiRAM forms and writing it in a way that the average reader can understand.

Example of description of wetland type and function.

Wetland/Water Category	NWI Class	NWI Description	Study Area Relative Abundance[1]				
			M	T	K	B	P
Evergreen Forested Wetlands	PFO4	Forested, Needle-leaved Evergreen	A	A	+	uk	+
Deciduous Forested Wetlands	PFO1	Forested, Broad-leaved Deciduous	-	-	+	uk	+
Mixed Forested Wetlands	PFO1/4	Forested, Broad-leaved Deciduous/ Needle-leaved Evergreen	+	+	+	uk	+
Evergreen Scrub Shrub Wetlands	PSS4	Scrub Shrub, Needle-leaved Evergreen	A	A	+	+	+
Deciduous Scrub Shrub Wetlands	PSS1	Scrub Shrub, Broad-leaved Deciduous	+	A	+	+	A
Herbaceous Wetlands	PEM1	Emergent, Persistent	+	+	+	+	+
Ponds	PUB	Unconsolidated Bottom	-	-	+	+	+
Lakes	L1, L2	Limnetic, Littoral	np	np	np	uk	-
Rivers	R1, R2, R3, R4	Tidal, Lower Perennial, Upper Perennial, Intermittent	+	+	+	+	+

Function	Depression	Flat	Slope	Riverine	Lake Fringe
Modification of Groundwater Discharge	Yes	Yes	Yes	Yes	No
Modification of Groundwater Recharge	Yes	Yes	No	Yes	Yes
Storm and Floodwater Storage	Yes	Yes	Yes	Yes	Yes
Modification of Stream Flow	Yes	Yes	Yes	Yes	Yes
Modification of Water Quality	Yes	Yes	Yes	Yes	Yes
Export of Detritus	Yes	Yes	Yes	Yes	Yes
Contribute to Abundance and Diversity of Wetland Flora	Yes	Yes	Yes	Yes	Yes
Contribute to Abundance and Diversity of Wetland Fauna	Yes	Yes	Yes	Yes	Yes

<u>Key Finding # 2 Indirect impacts from dust</u>

Additionally, the indirect impacts on wetlands did not consider the impact of dust – both non-toxic road dust and mineralized dust from ore stockpiles – on wetland vegetation. Figures (e.g. Vol I Figure 3-1) do not even show where access roads and roads throughout mine-site are planned. It is common for mining operations to determine wind directions, strength, and estimate dust volume and direction. Some mitigation (e.g. wetting stockpiles) can reduce dust in summer, butmay be implausible in winter. Dust entrained in snow and ice may cover vegetation once snow is melted.

Another source of dust will be the waste rock piles. There is no description of what will be placed in the "mine waste storage area" on the southern perimeter of the pit, but it would make the most sense for the mining company to place waste rock here. Due to the proximity to wetlands, this is a potential source of dust impacts.

- **Impacts of dust must be analyzed as part of "indirect impacts due to proximity" of wetlands.**

The reclamation plan still refers to flotation tails being moved to the oxide TWRMF (VolVIII, App B3, Tables 1-2). Is this outdated? It also states "*The only Project feature that will remain (following closure) is the capped and reclaimed tailings and waste rock stockpile. This facility is much smaller than that which will exist during operations,* ***because much of the waste rock will be relocated to the pit*** *following operations… "*. Will backfill waste rock be located at the mine waste storage area on the southern perimeter of the pit? Will some waste rock still need to be moved from the TWRMF to the pit for backfill? These are relevant to the make-up of dust from waste rock piles that could impact wetland vegetation. This would most likely be high-sulfide waste rock material; storing it in this location poses much higher risks to aquatic resources if there is uncaptured runoff or uncaptured leachate. If mine life is extended beyond seven years, the material will continue to pose a risk until the point when it is finally backfilled and flooded.

<u>Key Finding #3 Wetland Hydrology</u>

<u>On-site data collection</u>

Other than piezometer data, no information that went into the water balance was collected on site. Precipitation is from Stephenson, MI 1971-2000, using 1965 (flood year) rainfall distribution (Vol R Section 5). Run-on (to wetlands), evapotranspiration, and run-off (from uplands) were not data collected on site but from USGS reports (1974, 2012) and other sources. Evapotranspiration was also estimated using an online calculator for irrigated alfalfa and data from a lakeshore, resulting in a range from 18"-34" per year. Run-off (to wetlands) from USGS and NRCS ranged from 6" – 14" per year, depending on soil types and the purpose of the study (USGS – determining runoff, NRCS – determining stormwater flows).

- **On-site data should be collected for the water balance.**

The model assumes that all snowmelt will leave evenly over a 30 day period in April, and this will recharge the groundwater (Vol R, Sections 5, 6). There is no observational, historical, or on-site evidence that this assumption is adequate. There are several problems with this.

- If ground freezes before snowmelt, much more will run-off than will recharge groundwater.
- If sediments are muck, silt, and clay, snowmelt will run-off rather than recharge groundwater.
- If the wetland is already flooded, additional water will runoff, not infiltrate.
- There is no assessment of actual snow-water-equivalent (SWE), which makes it impossible to determine the amount that could be available to recharge wetlands.
- There is no assessment of weather or climate trends, which indicate increased periods of heat and drought. Evapotranspiration will be higher in droughts and snowmelt recharge will be lower if precipitation occurs as rain in the fall rather than snowmelt. These need to be included as part of a range in assessing hydrologic impacts.

Vertical conductivity data was not collected on site, but was estimated to be 1/10th of horizontal conductivity measured in slug tests. Monitoring River flow and volume directly upstream and downstream of the site, along with collection of SWE and vertical conductivity, would provide some information on the timing and release of snowmelt. Collecting this data on site is necessary to determine the range of infiltration and run-off during snowmelt, which is the critical period for recharging wetlands.

- **On-site data should be collected for infiltration.**

<u>Sump pumps</u>
Sump pumps to collect seepage from the TWRMF are now in different locations, including very close to some wetlands, including Wetland C1 and Wetland 40/41 (Vol I Figure 3-1). Was any analysis done to determine if the sumps could impact wetlands hydrologically?

<u>Seepage into pit</u>
It is difficult to understand why a cut-off wall is needed to prevent Menominee River water from entering the mining pit, but adjacent wetlands, connected to groundwater, are not expected to lose water to the pit (Vol VIII App B4). It seems reasonable to consider designing the cut-off wall to extend along the southern perimeter of the pit and reduce potential loss of groundwater from Wetland 14/15.

<u>Seepage out of pit</u>
Post-closure, contaminants are expected to flow out of the pit through the alluvial aquifer, which will dilute them sufficiently before groundwater carrying diluted pit water discharges to the river (CSP2 2017). The Wetland Permit Application emphasizes the intermittent nature of streams and the seasonal flux in groundwater to wetlands (Vol VIII App B1 and others). The groundwater hydrology model applied in the wetland and mining permits must be adequate and consistent in modeling groundwater that impacts seasonal and operational – related wetland drawdown as well as contaminant dilution post-backfill.

Key Finding #4 Aquatic Resource Integrity and Economic Viability

Water Treatment Plant

The wastewater treatment plant (WWTP) is intended to clean mine water from contact water basins to permittable effluent limits (NPDES permit, April 2017). Theoretically, the discharge water would pose no problems for mussels located at the outfall. However, mussels will be relocated upstream – which is a good decision, because there are very serious problems with both the WWTP and the NPDES permit effluent limits (NPDES permit #MI0059945 and associated documents). These issues will put aquatic resources at risk.

First, there are analytes that have no permit effluent limits. ***By EPA regulation, any analyte determined to have a reasonable potential to exceed water quality criteria must be placed in a permit with limits.*** A statement that "the water treatment plant will clean it" is not sufficient. In the proposed mussel relocation plan (Vol VIII, App B-6), there are no permit effluent limits for aluminum (Al), iron (Fe), ammonia (NH_4), or sulfate (SO_4^{2-}) among others, despite average concentrations in the contact water basin that would be highly toxic (Table 1and Table 2 in the referenced section). There are also issues with the level of pollutants allowed by permit (based on Table 1) – arsenic, copper, lead, manganese, cadmium, chromium, zinc would all be released at levels that are toxic to aquatic resources. The solution by the state is to release them in toxic concentrations and allow the river to dilute them out. This is an antiquated method for the "co-existence" of natural and non-renewable resources, when there are technologies available to treat water to concentrations safe for aquatic life. When considering "safe levels" for wastewater discharge, acute and sub-acute impacts – such as fish avoidance and impacts on olfaction and lateral line/balance – need to be considered. Comments raised by USFWS in the NPDES permit application were not sufficiently addressed.

The water treatment required to remove metals such as Al and Fe are different from the equipment needed to remove ammonia or sulfate. There is a sentence that says "lime and membranes should reduce [sulfate] below toxic impact level of 58 mg/L", indicating the company is looking at lime and/or membrane treatment systems. Lime treatment will not remove ammonia or sulfate to the necessary levels. Membranes alone can remove sulfate, but will not work unless iron is precipitated before feed water enters membranes. A combination of treatment systems will be required.

Why does this matter to the wetlands permit? First, in order to adequately determine the mixing zone and the areal extent from which mussels will need to be removed (Vol VIII App B6), the regulators need to be provided with a good estimate of WWTP effluent analyte concentrations. This cannot be done by saying "Michigan Primary Effluent Limits will be met". A WWTP needs to be designed in a manner that will adequately treat the feed water. Ideally, simulated feed water will have been run through lab scale and pilot scale plants to fine-tune the system. This should have been available with the NPDES permit application, but as of December 2017, eight months after the NPDES permit was issued, there was still no design.

> *"The Back Forty Project has not completed engineering and planning for water related facilities at this time. To provide you with as current and relevant information as possible, we would prefer to postpone these submittals until December 31, 2018."* (Aquila Resources, Dec 11 2017)

For an example of the scale to which a WWTP should be designed at this stage in the permitting process, see the attached document (NPDES permit application, Donlin mine, Alaska, 2017).

This matters because putting together an adequate WWTP costs money. The mine appears to expect a low profit margin already. If the WWTP turns out to be inadequate, the result will likely be a larger mixing zone and place even more aquatic resources at risk.

When considering the options and alternatives, the design, effectiveness, and cost of the WWTP is an essential component. Is there a mine, operating or abandoned, that already has milling and water treatment capabilities? In the Alternatives, there is no real analysis of the alternative to mill offsite, nor is there an economic analysis that would weigh benefits of milling off-site (reduced direct and indirect wetland impacts, including impacts from dust; reduced or no need for mussel relocation; reduced need to compensate for impacted wetlands) with the costs and impacts (risk of spills, potential increased impacts at the new location) (Vol II Section 6).

- **Aquatic resources are at greater risk than estimated if the WWTP is inadequate and the mixing zone is expanded.** The ability of the mining company to build and operate an adequate WWTP has not been shown; there is no design or cost estimate for the WWTP.

- **The mixing zone could be completely eliminated with an adequate WWTP.**

- **An alternatives analysis must consider the cost of an adequate WWTP in the mining-company preferred scenario against costs and benefits of other alternatives, including off-site milling.**

<u>Baseline water quality data</u>
In order to determine if natural conditions are changed in the River or adjacent wetlands during operations, or if reclamation goals have been achieved post-mining, adequate baseline data is required. The baseline water quality data (Vol VIII App B2) was mostly collected a decade ago, and is extremely minimal with collection on only two dates in March, June, September (or July), and December (surface water and monitoring wells, 2007-2009) and collection for piezometers/wetland water chemistry once each in April, May, and December (2010-2011) with some minimal additional data.[1] This is entirely insufficient to determine natural variability in surface water, groundwater, and wetlands. It likely does not cover the periods when the landscape is the driest.

- **Additional baseline water quality is needed for monitoring operational changes to water quality/impacts to aquatic resources and progress in wetland reclamation goals.**

[1] July 2008 at two monitoring wells; one monitoring well April 2010; two wetland chemistry in October 2010, 2011; wetland chemistry at 4 sites in July 2011; cations in surface water on 3 dates 2010-2011.

Key Finding #5 Mussel relocation

There is an implicit assumption that mussel relocation will be a one-time event (Vol VIII App B6). This is unrealistic. Mussels spawn by broadcasting eggs and sperm into the water, and it is reasonable and foreseeable to expect them to repopulate the stretch of river from which they are removed.

The relocation plan noted that they found mussels living down to 3 meters deep into the sediment and within 20 meters of shore. When mussels are relocated, will the entire area across the 130-foot long stretch of the mixing zone (and at least 15 feet from shore) be probed 3 meters deep to locate, collect, and remove mussels? Is there potential to mobilize a significant amount of sediment that could harm downstream resources during this process?

It is unlikely that any action can be taken to prevent mussels from re-establishing in the area. An analysis should be conducted to determine how frequently re-location would need to occur (as every "x" number of years, given that the mine life is likely to extend beyond seven years), the cost associated, the number of possible relocation sites, and how the ecosystems at relocation sites could be impacted by an influx of hundreds of mussels placed at one time. This needs to be considered against the cost of a WWTP designed to treat wastewater to levels that are safe for aquatic life, and the option to mill (and treat wastewater) off-site.

- **Provide an analysis of the potential for mussels to re-establish in the area cleared during re-location, and associated timelines and costs for additional removal actions.**

- **Compare the cost of repeated relocation efforts with the cost of an effective WWTP or milling off-site.**

Key Finding #6 Mercury methylation

Related to the quality of effluent allowed as discharge is the increased potential for, and increased risk to aquatic resources from, mercury methylation. Total mercury (HgT) is already elevated in places along the Menominee (and Shakey) River(s) (Vol VIII App B2). Although total mercury is important, to monitor the risk to aquatic life the form of mercury needs to be determined. It is the methylmercury (MeHg) form that moves through the food chain and increases impacts on both aquatic resources and consumers. Sulfate, which will be discharged by the WWTP with no permit effluent limits, can stimulate the conversion of Hg to MeHg, particularly at the sediment-water interface where benthic aquatic organisms live, along with any mussels that were not re-located or who establish in the area.

Alternatively, MeHg is frequently formed in wetlands. Would there be a reduction in generating MeHg or transporting MeHg to the River based on removal and reduction of wetlands on the property?

Methylation potential can also vary between different types of wetlands. This should be considered when assessing the function and value of impacted and compensatory wetlands.

- **The potential change in risk to aquatic organisms from mercury methylation has not been assessed.**

- **Monitoring should require water quality analysis for total and methyl mercury. Fish tissue and mussel tissue sampling should include analysis for methylmercury.**

__Additional comments__

- There is no information on how the new proposed mine waste storage area will be constructed, particularly with regards to presence and thickness of a liner and details of a leak detection system, critical given the proximity to the Menominee River and wetlands (Vol VIII, App B3).

- The 100-year floodplain delineation, based on 1992 information, did not consider recent ice jams that have caused flooding on the River, or climate trends that predict greater precipitation in fall (Vol VIII, App B7).

- Reclamation plans include constructing wetlands on top of the backfilled pit (Vol R, Figure 5-2). First, this is not feasible until after the full mine workings – which are reasonably and foreseeably expected to include underground mining with adit entrances from the pit – are closed. Second, given the permeability of the backfill material (CSP2 2017), constructing wetlands in this location could increase, rather than decrease, the risk of contaminant mobilization.

- Why was the area on the eastern project boundary, abutting the Shakey River, not considered as a location for compensatory mitigation? This is an area that could be directly impacted by the project.

Thank you for the opportunity to comment on the wetland permit. Please feel free to contact us with questions or for further information.

Regards,

Kendra Zamzow

Kendra Zamzow, Ph.D .

2.2 Facility and Wastewater Description

The proposed Donlin Gold project facility consists of the following major elements:

- An open pit mine;
- A process plant that concentrates gold bearing minerals from the ore through crushing and grinding, gravity concentration, and flotation;
- Anaconda Tailings Storage Facility (TSF) with an engineered dam, located in Anaconda Creek drainage;
- Waste Rock Facility (WRF) for the disposal of waste rock;
- Water management systems that maximize recycling and treat all waters affected by the project in accordance with pertinent federal and state legislation;
- On-site power generation and electrical distribution;
- Construction and permanent camp facilities with showers, lavatories and dining facilities; and,
- An assortment of shops, warehouses, and offices to support mine operations.

The permit authorizes the discharge of treated wastewater to Crooked Creek from Outfall 001. The proposed facility is expected to operate at a net positive water balance thus necessitating the need to discharge excess water. The wastewater treatment plant (WTP) facility and Outfall 001 location are shown on Figure 1. The WTP will utilize clarification, oxidation and greensand filtration, with reverse osmosis (RO) as required. A process flow diagram of the Operations WTP showing the flow through each treatment unit is included as Figure 2. The WTP will have a combined maximum design capacity of approximately 4,750 gallons per minute (gpm), with an anticipated maximum treatment rate of approximately 4,500 gpm.

Influent sources to the WTP will vary in flow over time and is dependent on the facility activities over the course of the life of mine (LOM) and include:

- Contact Water Dams (CWD) located at the upper and lower ends of the WRF;
- Tailings Storage Facility (TSF);
- Seepage Recovery System (SRS);
- Domestic wastewater; and,
- Pit dewatering.

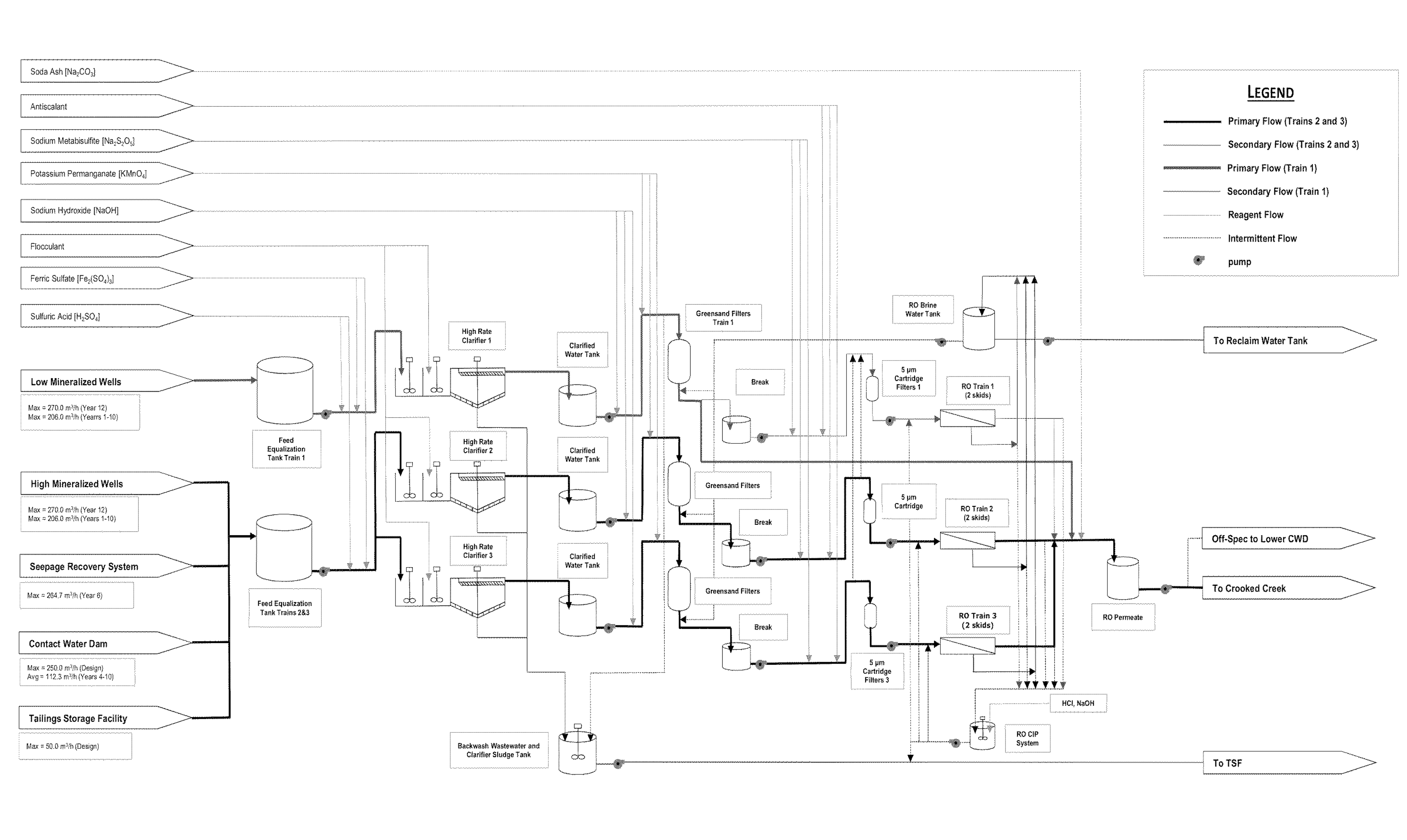
The maximum flow to the WTP from the dewatering wells will be approximately, 2,300 gpm, which is predicted to occur in the mid-point of LOM. Over the operations period a maximum seasonal rate of approximately 1,100 gpm from the CWDs, 44 gpm from the TSF, and approximately 800 gpm from the SRS would be treated. The maximum combined flow to the WTP is approximately 4,500 gpm, which is predicted to occur in the mid-point of LOM (approximately in Year 12 LOM). Maximum monthly flowrates from the influent sources for each year of operation were estimated from the water balance model.

The treatment process will include two feed equalization tanks. The first tank will exclusively receive feed from the pit dewatering wells with relatively good water quality, referred to as low mineralized wells. The second tank will collect the incoming feed from the CWD, SRS and TSF sources as well as from pit dewatering with relatively poor water quality, referred to as high mineralized wells. The first tank containing well water will feed Train #1. The second tank will ordinarily feed Trains #2 and Train #3. Blowers will supply air to the WTP feed tanks for mixing and to allow for iron oxidation. From the feed water tanks, the water in each train will be pumped to high rate clarifiers (HRCs). Sulfuric acid and ferric sulfate will be dosed in line ahead of the HRC to adjust pH for the iron co-precipitation process. The pH and ferric sulfate dosage will be adjusted to optimize antimony removal. In the HRC, a polymeric flocculent will be added to assist with the agglomeration of the precipitated ferric hydroxide and co-precipitates. The solids are separated in the clarification step. The overflow (treated water) from the HRC clarifier in each train will be collected in the clarified water transfer tank, and then pumped to the greensand media filters. The greensand media filters will be dual media filters. The top layer will be anthracite intended for TSS removal and the bottom layer will be the greensand media itself. Potassium permanganate ($KMnO_4$) will be injected upstream of the greensand filters to treat manganese. The greensand filters will be backwashed with air and water. Brine from the RO system will be used for backwash water. Wastewater from filter backwash will be sent to the Backwash Wastewater/Clarifier Sludge Receiver Tank. This combined wastewater will be pumped to the TSF or used in the process.

RO pre-treatment to protect the membranes from oxidation, scaling, and fouling includes antiscalant addition and a 5-micron absolute cartridge filtration system installed ahead of the RO system. The RO systems are designed to operate at 75% recovery. The brine from the RO process will be collected in the RO brine water tank. The majority of the water from the brine water tank will be pumped to the reclaim water tank for reuse in the process plant. A small amount of the brine will be used for backwashing the greensand filters. Water from the brine water tank will be pumped to the reclaim water tank for reuse in the process plant or discharged to the TSF.

RO permeate will be discharged to the RO permeate water tank. Before entering the tank, the pH will be adjusted to within the discharge range (7.5 – 8) by addition of soda ash (Na_2CO_3) and to also increase the alkalinity of the treated water as required. It is not expected that RO treatment will be required for the higher quality pit dewatering well water being treated in Train #1. Typically discharge from the greensand filters in Train #1 will be directed to the RO permeate water tank. RO units will be available to be used in Train #1 as a back-up system when required to meet discharge standards. In normal operation, treated water from Trains 1, 2, and 3 will be pumped from the RO permeate water tank to the discharge outfall at Crooked Creek. If, for any reason, the treated water is out of compliance with permit limitations, then the water will be transferred to the Lower CWD until the problem is resolved.

A modular sanitary treatment plant (STP) system would be provided for the treatment and discharge of domestic wastewater from the permanent camp facilities about six-miles west of the plant site is designed to accommodate 638 people. Effluent from the STP will be discharged into the Anaconda Tailings Storage Facility (TSF) which ultimately is routed to the WTP and discharged into Crooked Creek at Outfall 001. Bio-solids from the STP would be incinerated after filter pressing to remove excess water.



DONLIN GOLD

OPERATIONS WTP PROCESS FLOW DIAGRAM

DONLIN GOLD PROJECT

SCALE:

FIGURE: 7